Healthwatch-2

A general purpose software research tool designed to facilitate the development and testing of power train health monitoring algorithms.

Background

The Healthwatch-2 (HW-2) software system developed at NASA Ames Research Center is designed to support research into power train damage detection algorithms. In particular, it allows rapid prototyping of advanced health monitoring concepts and algorithms. The system is written in C/C++ and executes on an x86-based computer running the Linux operating system. The HW-2 executive module has interfaces to collect data from various sources, for example, accelerometers, torque meters and tachometers. It may be reconfigured for real-time use with a broad range of mechanical systems.

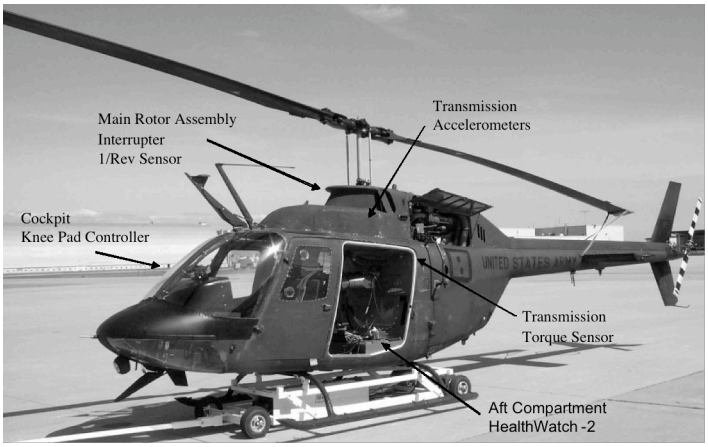
Some of the special features of HW-2 are:

- Real-time processing of time and/or frequency averages is controlled by a user-supplied supplied configuration file allowing flexibility in choosing constrains on the data to be averaged.

- Health monitoring algorithms are written as Matlab functions and then compiled and called by HW-2 during operation, easing the development and integration of new algorithms into the system.

- Archived data can be "replayed" to test algorithms in the laboratory, which allows researchers convenient control over the transition from exploratory development to deployment.

Healthwatch-2 was installed to monitor the main transmission on an OH-58C Kiowa helicopter in September 2003. Since October 2003, it has been used to collect and process data in-flight. A system is currently being built for an EH-60L Blackhawk helicopter to monitor the main transmission, intermediate and tail rotor gear boxes.



OH-58C Helicopter Instrumented with Healthwatch-2 System

Research Overview

Specific research objectives and underlying motivations for developing the HW-2 system are as follows:

- Determine the characteristics of undamaged gear trains in normal usage and evaluate damage detection metrics published in the open literature. Thresholds for most damage detection metrics were developed under static test stand conditions. Experience has shown that the normal usage often causes monitoring metrics to exceed the thresholds established under such conditions.

- Determine the degree of cyclostationary of gear trains under various dynamic conditions. Experience has shown that data collected under what are thought to be identical conditions have strong non-cyclostationary characteristics.

Healthwatch-2

• Develop and evaluate signal separation algorithms for planetary gear systems. Most approaches to signal separation of planetary gears require long sampling periods, which are subject to non-cyclostationary influences.

• Collect and archive high quality raw data. As novel data preparation and damage detection algorithms arise, it is most efficient to evaluate them first in the laboratory using_archival data collected from various dynamic conditions.

• Process archived data. In addition to its real-time capabilities, HW-2 software is capable of reading archived data and processing it as if real-time. This allows algorithms to be developed and tested in the laboratory on a generic x86-based PC running the Linux operating system.

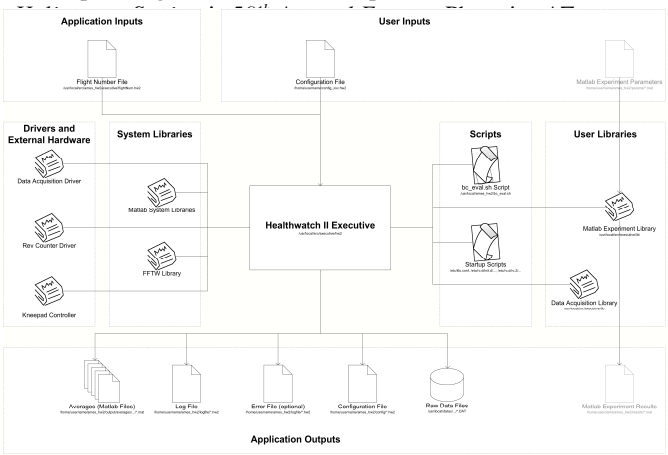
Recent Technical Papers

Barszcz, E., Mosher, M. and Huff, E. M., "Healthwatch-2 System Overview," presented at *American Helicopter Society's 60th Annual Forum*, Baltimore, MD, 2004.

Mosher, M., Huff, E. M. and Barszcz, E., "Analysis of In-Flight Measurements from Helicopter Transmissions," presented at *American Helicopter Society's 60th Annual Forum*, Baltimore, MD, 2004.

Tumer, I. Y. and Huff, E. M., "Analysis of Triaxial Vibration Data for Health Monitoring of Helicopter Gearboxes," *ASME Journal of Vibration and Acoustics*, vol. 125, pp. 120-128, 2003.

Huff, E. M., Mosher, M. and Barszcz, E., "An Exploration of Discontinuous Time Synchronous Averaging Using Helicopter Flight Vibration Data," presented at the *American*



Mosher, M., Pryor, A. H., and Huff, E. M., "Evaluation of Standard Gear Metrics in Helicopter Flight Operations," presented at *56th Meeting of the Society of Machinery Failure Prevention Technology*, Virginia Beach, VA, 2002.

Huff, E. M., Tumer, I. Y., Barszcz, E., Dzwonczyk, M., and McNames, J., "An Analysis of Maneuvering Effects on Transmission Vibrations in an AH-1 Cobra Helicopter," *Journal of the American Helicopter Society*, pp. 42-49, 2002.

Pryor, A. H., Mosher, M. and Lewicki, D. G., "The Application of Time-Frequency Methods to HUMS," presented at the *American Helicopter Society's 57th Annual Forum*, Washington D.C., 2001.

Huff, E. M., Barszcz, E., Tumer, I. Y., Dzwonczyk, M., and McNames, J., "Experimental Analysis of Steady-State Maneuvering Effects on Transmission Vibration Patterns Recorded in an AH-1 Cobra Helicopter," presented at the *American Helicopter Society's 56th Annual Forum*, Virginia Beach, VA, 2000.

Relevance to Exploration Systems

This research capability supports the following H&RT program /elements:

Software, Intelligent Systems, and Modeling

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